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DENTAL DISEASE IN A 17TH–18TH CENTURY GERMAN COMMUNITY IN JELGAVA, LATVIA

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ABSTRACT

Aims: To determine the frequency and distribution of dental caries,

the Duchy of Courland and Semigallia, and to compare these rates with those obtained from contemporary populations from urban and rural Latvian cemeteries.

Materials: The sample analysed consisted of the dental remains of 108 individuals (39 male, 42 female and 27 non-adults) excavated from the Jelgava Holy Trinity Church cemetery in Latvia. A total of 1,233 teeth and 1,853 alveoli were examined.

Results: The frequency of the observed conditions in this population was overall high but not anomalous for the post-medieval period in Latvia. The differences between the age and the sex groups when comparing the number of individuals affected were not significant. The number of teeth and/or alveoli affected by caries, the periodontal disease and the ante-mortem tooth loss proved to be significantly higher in females than males in both age groups and in total. The prevalence of enamel hypoplasia was high in both sex groups.

Conclusions: The overall high rates of destructive dental diseases in this population were linked to the diet high in soft carbohydrates and refined sugars. The significant differences between the number of teeth and alveoli in male and female dentitions affected by caries, the periodontal disease and the ante-mortem tooth loss were linked to a differential diet, as well as high fertility demands and differences in the composition of male and female saliva. The large number of the adult individuals affected by enamel hypoplasia proved that most of the population was subject to severe metabolic stress episodes during childhood, but that many children were likely to survive these hardships into adulthood. The comparison with other contemporary populations proved that all the Holy Trinity Church cemetery population had an equally high prevalence of dental diseases, especially with regards to other urban populations.

Key words*: skeletal remains, diet, status, childhood stress.*

INTRODUCTION

This study was initiated after recent excavations in the Jelgava Holy Trinity Church in Latvia, which provided a unique opportunity to look into the health status of a wealthy German community of the 17th and 18th centuries. Although it is acknowledged that the German population in Latvia was socially and economically advantaged over the native Latvian population [12: 234; 58: 7], the German society was stratified itself, and the period between the 17th and 18th centuries was politically complicated. Moreover, a high social status does not necessarily mean better health due to cultural differences, or during hardships such as wars, famines or epidemics [8; 31: 76; 47].

The dental disease was chosen as the main focus of this study because it is a useful tool for looking into many aspects of past populations including their diet, hygiene and social status, as well as the childhood stress [36: 261]. Teeth generally survive well in a wide variety of archaeological contexts, as opposed to other elements of the skeleton. As a result, the dental disease can be studied when other skeletal data are poor or not available. This enables comparisons among and between skeletal populations, provided that similar recording methods have been used and that the data are presented in an appropriate way [ibid: 273].

Consequently, three main aims have been set up for this study: 1) To record and assess the prevalence rates of dental diseases in the Holy Trinity Church cemetery population (HTCCP), 2) to compare these rates with those obtained from four broadly contemporary populations from urban and rural Latvian cemeteries, and 3) to find similarities and differences in the patterns of dental diseases between the HTCCP and the other four cemeteries.

MATERIALS

During the summer of 2009 and the autumn of 2010, one hundred and eight individuals were excavated from the inside of the Jelgava Holy Trinity Church during reconstruction work. The church was built for the German community of Jelgava in 1615, and used as their final resting place until 1780, when it was forbidden by law to bury people inside churches [**57].** Due to the restricted space the burials had to be laid on top of each other over time, and three layers of burials could be distinguished during the excavation [40].

Apart from the in-situ burials, a large number of isolated human bones were found, for which the MNI (Minimum Number of Individuals) was calculated as 320. This indicates that older burials were often destroyed by later ones. On the other hand, all the burials of the same layer followed a set order of rows [ibid.].

With regards to the preservation of the skeletal material, it was very well preserved, with most individuals having the cranial and post-cranial skeleton present. In total, there were 39 male, 42 female and 27 non-adult individuals in this skeletal collection.

For comparative analysis, the data on dental caries, periapical lesions and the ante-mortem tooth loss were compiled from the excavated cemeteries of Ventspils [15], Valmiera [56], Madona and Cesvaine [16]. Thanks to similar recording methods, the available data could be reliably compared. Where possible, the comparison of dental pathologies was carried out in the age and the sex groups.

Historical background

Between the 17^{th} and 18^{th} centuries Latvia was involved in wars between Sweden, Russia and Poland, each country wanted a share of land and accordingly, the control over trade routes [11; 12]. In this period, the city of Jelgava was the capital of the Duchy of Courland and Semigallia, which stretched from the southern-most part of Latvia across the whole south-western border to the Baltic coastline. This meant that the Duchy had access to all major international land and sea trade routes [11: 53]. The general population of Jelgava in this period was stratified according to the family income [42: 13]. It is believed that most people, buried in the Jelgava Holy Trinity Church cemetery, were wealthy citizens from the families rich enough to afford to bury their relatives within the church, which was essentially a paid service [56: 40].

Throughout the existence of the Duchy, every generation experienced war and subsequently, famines and plagues [11: 226]. These disasters particularly struck the inhabitants of Jelgava, as the city was a major political centre. Whenever the Duchy could not avoid being involved in war, Jelgava with the Duke's seat was the main target [ibid: 96]. Moreover, the population of the city was severely affected by the famine in 1697 and the plague shortly after [ibid: 146]. Jelgava allegedly lost 1,316 people just in one year during the Great Plague of 1710, which came amid yet another war (The Great Northern War (1700–1721)) [ibid: 191], leaving only about one third of the Jelgava population alive [28: 16].

METHODS

To estimate the age in adult individuals, a series of widely used methods were applied [2; 4; 26; 27; 34; 35; 41]. For non-adult individuals, mainly tooth formation and eruption methods were used [52: Tables 5.24–26, figs. 5.77–78] in combination with the epiphyseal fusion and long bone measurements where teeth were not available for study [14; 51]. Sex estimates in adult individuals were based on the subjective assessment of the morphology of the pelvis and the skull [5: 16–38].

For the observation of the dental disease, all the individuals with the present mandible and/or maxilla (even partly preserved), and at least one observable tooth/alveolus, were included in the analysis. The analysis was entirely macroscopic. The calculations and the analyses for each condition in adults were carried out by age and sex groups, dividing the individuals in those aged 20 – 40 (including two female individuals aged between 18 and 20 years), and above 40 years. Non-adult individuals age groups were not used due to the scarcity of pathological lesions.

For the recording of caries, mainly the methods developed by Hillson [21] and Lukacs [36] were used. Caries was identified as present only if there was a visible lytic lesion penetrating the tooth crown or root, and recorded as present or absent. In juveniles, all erupting and erupted teeth were observed. Periapical lesions were recorded as present only if they were associated with the apices of one or more roots, Lukacs [36: 271] and Ogden [46: 297]. No distinction between granuloma, cyst and chronic abscess was attempted [ibid.] because it was beyond the scope of this analysis. In juveniles, all the alveoli with partially of fully erupted teeth were observed. The periodontal disease was recorded as present or absent [3: 155]. In juveniles, only the alveoli with fully erupted, in-situ deciduous or permanent teeth were observed. The ante-mortem tooth loss was recorded as present if there were signs of remodelling, or if the sockets were completely remodelled. Calculus was recorded as present or absent and by its location above or below the gingival line (sub- or supragingival) [3; 22]. In juveniles, all the fully erupted teeth were observed. Enamel hypoplasia was recorded as present only if the hypoplastic defect was clearly visible without magnification. To record enamel hypoplasia, more than one tooth of any type had to be affected, to avoid recording the enamel defects caused by trauma. The defects were recorded according to their type (vertical or horizontal, groove or pit [5; 49]. No calculations of the age of formation were attempted due to the difficult interpretation of the measurements [24: 174]. In juveniles, all the teeth with fully formed crowns (including loose unerupted teeth) were observed. For statistically significant differences between the affected individuals and the number of affected teeth/alveoli in the age and the sex groups, the Chi-square and Fisher exact tests were used. The tests were performed using SigmaPlot, version 11.0, level of confidence $p<0.05$. The calculations for the prevalence of each condition were carried out both by observable individual count (crude prevalence) and by tooth/socket count (true prevalence). Prevalence rates were calculated based on the observable individuals and the observable teeth/alveoli for each dental disease.

RESULTS

It was possible to estimate sex in all the adult individuals in this population, and the non-adult individual from burial 17 (17–19 years old) could be reliably sexed as male. From the 108 excavated individuals, 31 male, 35 female and 19 non-adult individuals at least one dental disease for including could be observed in the analysis. Apart from the dental disease, the tooth wear, typical of regular clay-pipe smoking, visible as a distinctive foramen affecting the upper and lower second incisors and canines, was present in two male individuals (burials 26, aged 25–30 years and 59, 50+ years old).

Table 1. Crude prevalence of dental diseases in the Holy Trinity Church cemetery adult population (individual count)

Age (yrs)	Males	%	Females	%
Dental caries	(n/N)		(n/N)	
20–40	5/13	38.5	12/16	75.0
40+	10/15	66.7	11/16	68.8
Total	15/28	53.6	23/32	71.9
Periapical lesions				
20–40	2/13	15.4	9/16	56.3
40+	6/18	33.3	6/17	35.3
Total	8/31	25.8	15/33	45.5
Periodontal disease				
20–40	9/13	69.2	11/14	78.6
40+	15/15	100.0	17/17	100.0
Total	24/28	85.7	28/31	90.3
*AMTL**				
20–40	5/11	45.5	10/14	71.4
40+	15/18	83.3	18/19	94.7
Total	20/29	69.0	28/33	84.8
Calculus				
20–40	12/12	100.0	11/13	84.6
40+	13/13	100.0	12/12	100.0
Total	25/25	100.0	23/25	92.8
Enamel hypoplasia				
20–40	12/13	92.3	11/14	78.6
40+	12/14	85.7	10/12	83.3
Total	24/27	88.9	21/26	80.8

n – number of individuals with dental disease; N – number of individuals with observable teeth/alveoli; * – ante-mortem tooth loss

Regarding the dental disease, the prevalence of caries in adult individuals was high, especially among females in both age groups (Table 1). In total, 15 of 28 male and 23 of 32 female individuals were affected (53.6% and 71.9% respectively). The disease was more prevalent only in older male individuals, affecting fewer females in the older age group. Although considerably more females than males were affected by caries in the younger age group (75.0% and 38.5% respectively), this difference, based on crude prevalence calculations, was not statistically significant (χ^2=2.585, p=0.108). The number of carious teeth (true prevalence), however, was significantly higher in females than males in both age groups as well as in total (for all the calculated values based on true prevalence rates see Table 2). The number of carious teeth in male individuals significantly increased with age (from 3.3% to 8.1%). In females, the number of affected teeth reduced with age by 0.7 percent, but so did the number of observable teeth (Figure 1).

Figure 1. Gross caries and ante-mortem tooth loss in the maxilla of a female individual 50–60 years old (burial 71).

In non-adult individuals, caries affected two of 11 observable children (18.2%, burials 84 (12–13 years old) and 92 (2–2.5 years old), both had two lesions) and four of 128 observable teeth (3.1%).

Periapical lesions affected eight of 31 (25.8%) male and 15 of 33 (45.5%) female individuals (Table 1). There were significantly more teeth affected in female than male dentitions in the younger age group (Table 2). In 11 observable juveniles, only one had the lesion (9.1%, burial 17) and accordingly, one of 128 tooth positions was affected (0.8%)).

The analysis of the periodontal disease revealed a surprisingly high frequency of this condition in both adult age and sex groups, although it increased with age (Table 1). Based on crude prevalence calculations, in male individuals the increase with age was statistically significant (p=0.035), but not so in female individuals (p=0.081). The number of affected alveoli significantly increased with age in both sex groups (Table 2). The disease also affected significantly more alveoli in female than male dentitions in both age groups and in total (Table 2). In most of the adult individuals, the periodontal disease first affected the posterior teeth and advanced to affect the anterior teeth with increasing age. The condition was not observed in juveniles (nine individuals and 81 teeth in alveoli were examined).

The ante-mortem tooth loss was only present in adult individuals and the prevalence slightly increased with age in both sex groups. In total, 20 of 29 male (69.0%) and 28 of 33 female (84.8%) individuals were affected. As with caries and the periodontal disease, the number of the lost teeth differed significantly between males and females (Table 2), although the number of individuals affected was relatively similar (Table 1). There were significantly more teeth affected in females than in males in both age groups and in total, significantly more teeth were lost in older individuals in both sex groups (Table 2).

The supra-gingival calculus was present in almost every adult individual (48 of 50 (96.0%) of the observed male and female individuals (Table 1). The number of affected teeth significantly increased with age in both sex groups, and females had significantly less teeth with calculus deposits than males in both age groups and in total (Table 2).

The sub-gingival calculus was present in three of 25 (12.0%) male and nine of 25 (36.0%) female individuals, which all had the periodontal disease ranging from moderate to considerable. All the male individuals with the sub-gingival calculus were older than 40 years, but among female individuals two were aged between 30 and 40 years, and the other seven were older than 40 years.

In juveniles, the supra-gingival calculus was recorded in 3 of 9 observable individuals (33.3%) and 42 of 93 teeth (45.2%). No sub-gingival calculus deposits were present.

Table 2. True prevalence of dental diseases in the Holy Trinity Church cemetery adult population (tooth count), including chi square values*

Age (yrs)	Males	%	χ^2/p values (male age groups)	Females	%	χ^2/p values (female age groups)	χ^2/p values (age groups+totals between sex groups)
	n/N			n/N			
Dental caries							
20–40	11/334	3.3		40/253	15.8		**26.873/<0.001**
40+	23/284	8.1	**5.924/0.015**	31/205	15.1	0.00527/ 0.942	**5.285/0.022**
Total	34/618	5.5		71/458	15.5		**28.750/ <0.001**
Periapical lesions							
20–40	4/386	1.0		18/432	4.2		**6.484/0.011**
40+	10/490	2.0	0.820/0.365	11/545	2.0	3.152/0.076	0.0381/0.845
Total	14/876	1.6		29/977	3.0		3.244/ 0.072
Periodontal disease							
20–40	87/334	26.0		140/250	56.0		**52.730/<0.001**
40+	212/332	63.9	**94.678/<0.001**	167/206	81.1	**31.132/<0.001**	**17.273/<0.001**
Total	299/666	44.9		307/456	67.3		**53.923/<0.001**
*AMTL***							
20–40	20/386	5.2		49/432	11.3		**9.237/0.002**
40+	109/490	22.2	**48.713/<0.001**	247/545	45.3	**130.144/<0.001**	**59.871/<0.001**
Total	129/876	14.7		296/977	30.3		**62.477/<0.001**

Calculus							
20–40	293/333	88.0		174/241	72.2		**21.952/<0.001**
40+	268/268	100.0	**32.581/<0.001**	178/200	89.0	**18.123/<0.001**	**28.527/<0.001**
Total	561/601	93.3		352/441	79.8		**41.661/<0.001**
Enamel hypoplasia							
20–40	97/327	29.7		65/234	27.8		0.153/0.695
40+	58/238	24.4	1.682/0.195	70/171	40.9	**7.117/ 0.008**	**11.941/ <0.001**
Total	155/565	27.4		135/405	33.3		3.641/0.056

*values in **bold** are statistically significant; n – number of teeth with dental disease; N – number of observable teeth/alveoli; ** – ante-mortem tooth loss

Enamel hypoplasia had a high prevalence in the adult population in both sex groups (Table 1). Overall, there was a slightly higher frequency of defects in males than in females, 20 of 27 male (74.1%) and 17 of 28 female (60.7%) individuals had linear defects which appeared as grooves or, less common, as pits (Figure 2). Seven male and 11 female individuals had no enamel defects. With regards to the number of affected teeth, there were no significant differences between the sex groups in total, but significantly more teeth were affected in older females than in younger females and older males (Table 2).

After observing 19 juvenile dentitions and 157 deciduous and permanent teeth, no hypoplasic defects were found (0.0%).

Figure 2. Gross linear enamel hypoplasia in the form of grooves affecting the anterior and posterior mandibular teeth in a male individual aged 35–40 years (burial 23).

DISCUSSION

The results of the dental analysis proved that the prevalence of the observed diseases and conditions in the HTCCP was high. First of all, caries affected more than half of the adult population. It is known that one of the most influential factors in the development of caries is the diet comprising soft, sticky foods and refined sugar [7; 24: 291; 32: 179; 43; 44; 45]. In many, but not all the populations, older individuals and females in general are more likely to have the destructive lesions [8; 29; 31: 72; 32; 37; 38; 48; 50; 54]. Higher caries rates in females have most commonly been explained by a differential diet [8] and increased fertility demands [1; 32; 37; 38]. Both explanations are possible in the HTCCP. Firstly, it has recently been proven that the increase of oestrogen levels in female saliva during pregnancy can be responsible for higher rates of caries in this sex group [39: 547]. Accordingly, if women in the HTCCP had frequent pregnancies, this would inevitably result in more carious teeth. Secondly, historical sources suggest that the bread consumed by the upper classes in Latvia was made of finely ground pure grain and was quite soft [10]. Moreover, from the end of the 17th century sugar was imported from the Duke's own colonies in the Southern Atlantic Ocean [11: 61], and it would have been available for those who could afford to buy it. While the presence of carious foods in the diet was responsible for the overall high caries rates in the HTCCP, it could be that the diet of females was slightly softer and with higher amounts of refined sugar. Likewise, it has to be taken into account that the saliva flow rate is lower in females, thus also slowing the rate of food residue clearance from teeth and the restoration of the protective qualities of saliva after meals [38: 905; 39: 545–6].

The relative scarcity of carious lesions in juvenile individuals might be due to the fact that a number of partly or completely erupted teeth were lost post-mortem, reducing the number of observable teeth. It is also important to remember that caries is a disease that slowly progresses with age, and that probably the length of time carbohydrates were consumed in this population was too short for most of the children to develop carious lesions. Alternatively, the prevalence of the disease in children could have been very low due to a differential diet, especially with regards to the amount of refined sugar in the diet.

The observation of periapical lesions in the HTCCP proved that in most cases, they occurred in response to carious teeth. The cariesinduced infection of the pulp is known to be one of the most common reasons for the development of these lesions [22: 284; 23: 322]. The fact that young females in the HTCCP had more carious teeth than young males might explain the significant difference in the number of periapical lesions between the sexes in the younger age group. The presence of carious roots in both males and females, with the crowns lost to gross caries, indicate that in Jelgava it was not a common practice to extract teeth, although it is believed that the procedure was practised around the world since ancient times [23: 323; 53: 237].

The observation of the periodontal disease revealed markedly high rates in the Holy Trinity Church cemetery adult population. It is thought that the alveolar bone loss, which is the main consequence of the periodontal disease, is most likely caused by bacterial infection on the gingiva (the soft tissue surrounding the teeth) [20: 225–226; 31: 78]. On the other hand, while the mildest form of the periodontal disease, gingivitis, is a very common condition in living populations [53: 239], it only progresses into the destructive periodontal disease when the existing micro-flora of the mouth starts to change due to other processes affecting the mouth [6: 242].

The onset of the disease could also depend on the individual rate of caries and poor oral hygiene [31: 78]. As is the case with dental caries, the periodontal disease has also a higher prevalence in the populations which consume softer foods and thus have lower attrition rates [ibid: 80]. Accordingly, it is possible that the rates of caries combined with a soft diet and poor oral hygiene were the main contributing factors to the periodontal disease in this population. In addition, the nutritional status, as well as diseases such as scurvy could have affected its frequency [ibid.].

The relatively high prevalence of the ante-mortem tooth loss in the HTCCP is not surprising taking into account the equally high prevalence of other destructive dental diseases discussed above, which all can eventually lead to the tooth loss during life [31: 77; 46: 288]. Likewise, the significantly higher number of lost teeth in female dentitions is consistent with the higher rates of teeth and alveoli affected by caries and the periodontal disease in this sex group.

The almost 100% prevalence of the supra-gingival calculus in the Holy Trinity Church cemetery adult population is not unusual when compared to other archaeological populations [3: 160]. Its presence on the teeth is commonly linked to the level of oral hygiene in the population, although the calculus formation also depends on other factors such as the diet and inheritance [24: 289; 33]. It is believed that the diet high in protein can result in more severe deposits [ibid.]. The high overall prevalence of the supra-gingival calculus in the HTCCP could indicate poor oral hygiene. The significant differences in the number of affected teeth between age groups in male and female individuals suggest a gradual increase in the deposits with age. Significant differences in the number of teeth with calculus deposits between males and females in both age groups and in total could be linked to the presence of more dietary proteins in the diet of male individuals.

The sub-gingival calculus, on the other hand, is only associated with the periodontal disease [23: 312], and this was also the case in the HTCCP. As the periodontal disease was somewhat more prevalent in females, the higher number of individuals with sub-gingival calculus in this sex group is not surprising.

Finally, the adult population of the Holy Trinity Church cemetery had high frequencies of enamel defects. Enamel defects only occur in early childhood during the process of tooth crown formation [17: 64]. It has been suggested that the disrupted enamel formation on the tooth crown can be either hereditary, traumatic, or caused by a systemic metabolic stress such as nutritional deficiencies and/or diseases [18: 280; 31: 44–45]. In living populations, the formation of dental enamel defects depends on a variety of factors including environmental conditions, the time period in question, the level of development of the country, and the ethnicity of the affected individuals [9: 85; 13; 19; 25]. In most archaeological populations, however, where the defects affect numerous teeth in the same individual, they are believed to have resulted from a systemic metabolic stress [9: 81; 18: 281; 30: 547]. With regards to the HTCCP, this is consistent with the historical data about the frequent wars and subsequent outbreaks of plague and possibly other infectious diseases that this population endured. Moreover, during country-wide famines, it is possible that there was no, or very little, food available in the city of Jelgava. It has been reported that the children born during, or shortly after a major famine develop enamel defects [31: 46], and this might have been the case for at least some individuals in the HTCCP. The significant differences in the number of affected teeth between older male and female individuals might suggest that during certain periods such as wars boys received better care than girls, taking into account that many of the excavated individuals might represent the same generation [40]. To better explain the differences, however, the defects would have to be analysed and compared according to the affected tooth types in each individual, as it is known that some teeth are more susceptible to the formation of defects than others [9: 84; 19: 11].

With regards to the absence of enamel defects in the non-adult population, it might be possible that the defects on deciduous teeth would be visible with magnification. As a large number of juvenile teeth were lost post-mortem, it is possible that the teeth with enamel defects were among those lost. Alternatively, it has been demonstrated that enamel defects occur in the children who were healthy enough to actually survive childhood stress episodes [55: 355]. The high frequency of enamel defects in the adult population of the Holy Trinity Church cemetery indicates a relatively good chance of survival during hardships. The lack of enamel defects in the non-adult population might therefore represent the weaker individuals who died before enamel disruption became observable on their dentition.

The prevalence of dental caries, periapical lesions and the ante-mortem tooth loss in the HTCCP was compared to two rural low status (Madona and Cesvaine [16]) and two small town moderate status (Ventspils [15] and Valmiera [56]) populations (Table 3). There were no data on periapical lesions for the urban Valmiera population, and no data by the age group in the rural Madona and Cesvaine populations.

Table 3. Dental disease by age and sex groups in broadly contemporary Latvian cemetery populations (crude prevalence/individual count)

	Dental caries	%	*Periapical lesion*	%	*AMTL**	%
	n/N		n/N		n/N	
HTCCP						
Males						
20–40	5/13	38.5	2/13	15.4	5/11	45.5
40+	10/15	66.7	6/18	33.3	15/18	83.3
Total	15/28	53.6	8/31	25.8	20/29	69.0
Females						
20–40	12/16	75.0	9/16	56.3	10/14	71.4
40+	11/16	68.8	6/17	35.3	18/19	94.7
Total	23/32	71.9	15/33	45.5	28/33	84.8
Ventspils**						
Males						
20–40	4/10	40.0	3/10	30.0	3/10	30.0
40+	12/15	80.0	8/18	44.4	8/13	72.2
Total	16/25	64.0	11/28	39.3	16/23	57.1
Females						
20–40	4/7	57.1	4/9	44.4	5/9	55.6
40+	6/10	60.0	6/11	55.5	9/11	81.8
Total	10/17	58.8	10/20	50.0	14/20	70.0
Valmiera**						
Males			*No data*			
20–40	2/4	50.0			1/4	25.0
40+	1/7	14.3			7/10	70.0
Total	3/11	27.3			8/14	57.1
Females			*No data*			
20–40	4/5	80.0			0/4	0.0
40+	5/7	71.4			4/7	57.1
Total	9/12	75.0			4/11	36.3
Madona[1]						
Males (Total)[2]	6/8	75.0	1/7	14.3	9/14	64.2
Females (Total)[2]	7/9	77.8	1/7	14.3	7/13	53.8
Cesvaine[1]						
Males (Total)[2]	4/14	28.5	5/21	23.8	12/23	52.2
Females (Total)[2]	4/11	36.4	8/19	42.1	13/19	68.1

n – number of individuals with dental disease; N – number of individuals with observable teeth/alveoli;

* – ante-mortem tooth loss; ** – urban moderate status; [1] – rural low status; [2] – data by age group not available

The comparison revealed that the HTCCP had the highest rates of caries among the observed urban populations (63.3% against Ventspils (61.9%) and Valmiera (52.1%)), whilst rural Madona and Cesvaine revealed the highest and the lowest caries rates among all the comparative populations (76.4% and 32.0% respectively). In the HTCCP, the rates of the ante-mortem tooth loss were the highest overall (77.4% against urban Ventspils (69%) and Valmiera (48%) and rural Madona and Cesvaine (both 59.0%)). The rates of periapical lesions in the HTCCP were the second highest after Ventspils (35.9% and 43.0% respectively). In rural Madona the rates were the lowest overall (14.2%), while in rural Cesvaine the rates of periapical lesions were very similar to caries rates in this population (32.5%). No patterns in the observed dental disease rates when comparing urban versus rural or high status versus low status populations could be distinguished. Dental disease rates in the HTCCP and urban Ventspils, which was a major port, were similar regardless of status differences. This pattern, especially with regards to caries, could partly be due to the availability of refined sugar within the Duchy. For a more reliable explanation, however, more detailed information on the dental status in the Ventspils population would be necessary.

Valmiera, Madona and Cesvaine, on the other hand, were all under the rule of the Polish-Lithuanian Commonwealth. It is possible that the factors such as cultural beliefs, fertility demands, availability of foods and the general quality of life differed substantially in the regions ruled by different political powers, and that these differences are at least partly responsible for the lack of dental disease patterns in the compared populations. On the other hand, the substantial differences between the neighbouring rural Madona and Cesvaine populations might be due to the quality of life that different landlords in the same region provided to their subjects. More data on the dental status from these populations, such as tooth wear and the number of affected teeth would be necessary for a more informed interpretation.

With regards to the differences between age and sex groups, while some similarities between populations could be observed, there were also exceptions. For example, the caries rates proved to be higher in female individuals in almost all of the observed populations except urban Ventspils where the rates in female individuals were 5.2% lower than in male individuals (Table 3). Likewise, the caries rates increased by age in male individuals and decreased in female individuals only in the HTCCP and Ventspils population, but decreased in both sex groups in the Valmiera population.

The rates of periapical lesions in the HTCCP were lower than in the Ventspils population and higher than in the observed rural populations. Female individuals were affected more frequently than male individuals in all the populations except rural Madona, were the frequency was identical in both sex groups. The frequency of lesions in the female individuals of Ventspils population decreased with age, a trend that was not observed in the HTCCP.

Finally, the frequency of ante-mortem tooth loss proved to be higher in female individuals not only in the HTCCP but also in the Ventspils and Cesvaine populations. In Valmiera and Madona, however, it was higher in male individuals. In fact, the difference of ante-mortem tooth loss between the female individuals in the HTCCP and Valmiera population proved to be statistically significant ($p=0.004$). It is important to remember that both populations had also very high caries rates. Although such data were not available for the Valmiera population, it can be hypothesised that the severity of carious lesions, as well as the periodontal disease, was different between these populations. It has to be noted that the ante-mortem tooth loss was the only condition that increased with age in both sex groups in all the three urban populations for which the data were available. The dental wear typical of pipe-clay smoking, however, was only recorded in the HTCCP, and this could indicate that unlike sugar, tobacco was a commodity affordable exclusively to higher social classes at the time.

CONCLUSION

It can be concluded that the observed high prevalence of dental caries, periapical lesions, the periodontal disease and the ante-mortem tooth loss in the Holy Trinity Church cemetery adult population is linked to a diet comprising soft carbohydrates and refined sugar. The scarcity of dental diseases in the non-adult population, especially with regards to caries, is indicative of a differential diet for children or the slow progression of the disease with increasing age. The higher number of carious teeth in females might be linked to frequent pregnancies and the differences in saliva composition and flow rate. Alternatively, a softer diet could also have been responsible for the higher frequency of destructive dental diseases in this sex group. The possibility of differential diet between males and females was also supported by the higher number of teeth with calculus deposits in male dentitions.

The large number of adult individuals affected by enamel hypoplasia was suggestive of a short, but severe systemic metabolic stress during childhood, which could be linked to the problematic political and socio-economic situation in the city of Jelgava and the outbreaks of epidemics. Importantly, the presence of these enamel defects in the HTCCP indicated that the high status of these individuals did not save them from the hardships experienced by the entire society. Nevertheless, their presence also indicated the population's ability to survive these hardships beyond childhood. The significant differences observed in the number of affected teeth between males and females in the older age group ask for a more detailed analysis of the types of teeth affected, as this type of analysis could provide more clues to differential care for boys and girls during certain periods of time.

The inter-population comparison of dental caries, periapical lesions and the ante-mortem tooth loss revealed that no overall pattern based on the status or environment was observable. For all the compared dental diseases and conditions the prevalence of the affected male and female individuals in both age groups differed between the populations. The only exception was the ante-mortem tooth loss, which increasingly affected older individuals in both sex groups in all the populations. It seemed that overall the prevalence of dental diseases in the HTCCP was moderate, especially with regards to the two urban populations.

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